

AMENDMENTS TO THE CLAIMS

1-66. (Canceled)

67. (Previously presented) Scanning apparatus for scanning an object to generate three-dimensional data, comprising:

(a) a scanner mounted on a multiply-jointed arm for movement by an operator to scan the object to capture data from a plurality of points on the surface of the object, the scanner comprising:

(i) a light source operable to emit light onto the object surface; and  
(ii) a light detector operable to record light reflected from the object surface at different respective recording times;

(b) a position calculator operable to generate position data defining the position of the multiply-jointed arm at different respective times;

(c) a data synchronizer operable to determine the timing relationship between the recording times of the light detector and the position data of the multiply-jointed arm generated by the position calculator; and

(d) a three-dimensional data generator operable to receive data recorded by the light detector, position data generated by the position calculator and timing relationship data determined by the data synchronizer, and operable to process the data to generate three-dimensional data relating to the object.

68. (Original) Apparatus according to Claim 67, wherein the data synchronizer is operable to determine the timing relationship by determining the time difference between a recording time of the light detector and a time at which position data is generated by the position calculator, and determining therefrom a position of the multiply-jointed arm when the light was recorded by the light detector.

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69. (Original) Apparatus according to Claim 67, wherein the data synchronizer is operable to determine the timing relationship by reading position data generated by the position calculator defining the position of the multiply-jointed arm at a plurality of different times, and calculating therefrom a position of the multiply-jointed arm at a time of light recording by the light detector.

70. (Original) Apparatus according to Claim 69, wherein the data synchronizer is operable to interpolate between different positions of the multiply-jointed arm to calculate a position of the multiply-jointed arm at a time of light recording by the light detector.

71. (Previously presented) Scanning apparatus for scanning an object to generate three-dimensional data, comprising:

(a) scanning means mounted on a multiply-jointed arm for movement by an operator for scanning the object to capture data from a plurality of points on the surface of the object, the scanning means comprising:

(i) light emitting means for emitting light onto the object surface; and  
(ii) light detecting means for recording light reflected from the object surface at different respective recording times;

(b) position calculating means for generating position data defining the position of the multiply-jointed arm at different respective times;

(c) data synchronization means for determining the timing relationship between the recording times of the light detector and the position data of the multiply-jointed arm generated by the position calculator; and

(d) three-dimensional data generating means for receiving data recorded by the light detecting means, position data generated by the position calculating means and timing

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relationship data determined by the data synchronization means, and for processing the data to generate three-dimensional data relating to the object.

72. (Previously presented) A method of scanning an object having a surface to generate three-dimensional data, comprising:

moving a scanner mounted on a multiply-jointed arm to scan the object to capture data from a plurality of points on the surface of the object by lighting the object surface and recording light reflected from the object surface at different respective recording times to generate recorded light data;

generating position data defining the position of the multiply-jointed arm at different respective times;

determining the timing relationship between the recording times of the recorded light data and the position data of the multiply-jointed arm; and

processing the recorded light data and the position data in accordance with the determined timing relationship to generate three-dimensional data relating to the object.

73. (Original) A method according to Claim 72, wherein the timing relationship is determined by determining the time difference between a recording time of light data and a time at which position data is generated, and determining therefrom a position of the multiply-jointed arm when the light was recorded to generate the recorded light data.

74. (Original) A method according to Claim 72, wherein the timing relationship is determined by reading position data defining a plurality of positions of the multiply-jointed arm and calculating therefrom a position of the multiply-jointed arm at a time of light recording.

75. (Original) A method according to Claim 74, wherein the position of the multiply-jointed arm at the time of light recording is calculated by interpolation.

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76. (Previously presented) Scanning apparatus for scanning an object to generate three-dimensional data, comprising:

(a) a scanner mounted on a multiply-jointed arm for movement by an operator to scan the object to capture data from a plurality of points on the surface of the object, the scanner comprising:

(i) a light source operable to emit light onto the object surface; and  
(ii) a light detector operable to record light reflected from the object surface at recording times defined by a timing signal;

(b) a position calculator operable to generate position data defining the position of the multiply-jointed arm in response to a position data request signal;

(c) a signal generator operable to generate the timing signal for the light detector and to generate the position data request signal for the position calculator so as to cause the light detector to record reflected light and the position calculator to generate position data in a synchronous manner; and

(d) a three-dimensional data generator operable to receive data recorded by the light detector and synchronized position data generated by the position calculator, and operable to process the data to generate three-dimensional data relating to the object.

77. (Original) Apparatus according to Claim 76, wherein the signal generator is operable to generate the position data request signal for the position calculator using the timing signal for the light detector.

78. (Original) Apparatus according to Claim 76, wherein the signal generator is operable to generate the position data request signal for the position calculator in dependence upon the recording times of the light detector.

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79. (Previously presented) Scanning apparatus for scanning an object to generate three-dimensional data, comprising:

(a) scanning means mounted on a multiply-jointed arm for movement by an operator for scanning the object to capture data from a plurality of points on the surface of the object, the scanning means comprising:

(i) light emitting means for emitting light onto the object surface; and  
(ii) light detecting means for recording light reflected from the object surface at recording times defined by a timing signal;

(b) position calculating means for generating position data defining the position of the multiply-jointed arm in response to a position data request signal;

(c) signal generating means for generating the timing signal for the light detecting means and for generating the position data request signal for the position calculating means so as to cause the light detecting means to record reflected light and the position calculating means to generate position data in a synchronous manner; and

(d) three-dimensional data generating means for receiving data recorded by the light detecting means and synchronized position data generated by the position calculating means, and for processing the data to generate three-dimensional data relating to the object.

80. (Previously presented) A method of scanning an object having a surface to generate three-dimensional data, comprising:

moving a scanner mounted on a multiply-jointed arm to scan the object to capture data from a plurality of points on the surface of the object by lighting the object surface and recording light reflected from the object surface at recording times defined by a timing signal to generate recorded light data;

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generating position data defining the position of the multiply-jointed arm in response to a position data request signal;

generating the timing signal to control the reflected light recording and generating the position data request signal to control the generation of the position data so as to cause the reflected light to be recorded and the position data to be generated in a synchronous manner; and

processing the recorded light data and synchronized position data to generate three-dimensional data relating to the object.

81. (Original) A method according to Claim 80, wherein the position data request signal is generated in dependence upon the timing signal for the light detector.

82. (Original) A method according to Claim 80, wherein the position data request signal is generated in dependence upon the recording times of the reflected light.

83. (New) A scanning apparatus, comprising:

a multiply-jointed arm having a plurality of arm segments and a data communication link to transmit data; and

a scanner mounted on an arm segment of the multiply-jointed arm for movement therewith to capture data from a plurality of points on a surface of an object, the scanner having a housing enclosing:

(a) a light source operable to emit light onto the object surface;

(b) a light detector operable to detect light reflected from the object surface and to generate electrical image data signals in dependence upon the detected light; and

(c) a data processor operable to process the electrical image data signals to generate processed data of reduced quantity, the data processor being connected to the data communication link to transmit the processed data therealong.

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84. (New) A scanning apparatus according to Claim 83, wherein the data processor is operable to generate the processed data of reduced quantity by processing the electrical image data signals to generate measurement data and processing the measurement data to reduce the quantity thereof.

85. (New) A scanning apparatus according to Claim 83, wherein the data processor is operable to generate the processed data of reduced quantity by filtering the data.

86. (New) A scanning apparatus according to Claim 83, wherein the data processor is operable to generate the processed data of reduced quantity by discarding data.

87. (New) A scanning apparatus according to Claim 83, wherein the communication link comprises a cable.

88. (New) A scanning apparatus according to Claim 83, further comprising a battery power supply within the apparatus to power the scanner.

89. (New) A scanner mountable on a multiply-jointed arm for movement therewith to capture data from a plurality of points on a surface of an object, the scanner having a housing enclosing:

a light source operable to emit light onto the object surface;

a light detector operable to detect light reflected from the object surface and to generate electrical image data signals in dependence upon the detected light; and

a data processor operable to process the electrical image data signals to generate processed data of reduced quantity, the data processor being connectable to a data communication link to transmit the processed data therealong.

90. (New) A scanner according to Claim 89, wherein the data processor is operable to generate the processed data of reduced quantity by processing the electrical image data signals

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to generate measurement data and processing the measurement data to reduce the quantity thereof.

91. (New) A scanner according to Claim 89, wherein the data processor is operable to generate the processed data of reduced quantity by filtering the data.

92. (New) A scanner according to Claim 89, wherein the data processor is operable to generate the processed data of reduced quantity by discarding data.

93. (New) A scanning apparatus, comprising:  
a multiply-jointed arm having a plurality of arm segments;  
a scanner mounted on an arm segment of the multiply-jointed arm for movement therewith to capture data from a plurality of points on a surface of an object, the scanner having a housing enclosing:  
(a) a light source operable to emit light onto the object surface;  
(b) a light detector operable to detect light reflected from the object surface and to generate electrical image data signals in dependence upon the detected light; and  
(c) a data processor operable to process the electrical image data signals to generate digital image data; and  
a bus connected to the data processor of the scanner to transmit the digital image data.

94. (New) A scanning apparatus according to Claim 93, wherein the data processor comprises a frame grabber.

95. (New) A scanning apparatus according to Claim 93, further comprising a battery power supply within the apparatus to power the scanner.

96. (New) A scanner mountable on a multiply-jointed arm for movement therewith to capture data from a plurality of points on a surface of an object, the scanner having a housing enclosing:

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a light source operable to emit light onto the object surface;

a light detector operable to detect light reflected from the object surface and to generate electrical image data signals in dependence upon the detected light; and

a data processor operable to process the electrical image data signals to generate digital image data,

the data processor being connectable to a bus to transmit the digital image data.

97. (New) A scanner according to Claim 96, wherein the data processor comprises a frame grabber.

98. (New) A coordinate measuring machine, comprising:

a multiply-jointed arm having a plurality of arm segments and a physical data path to transmit data; and

a scanner mounted on an arm segment of the multiply-jointed arm for movement therewith to capture data from a plurality of points on a surface of an object, the scanner having a housing enclosing:

a light source operable to emit light onto the object surface;

a light detector operable to detect light reflected from the object surface and to generate electrical image data signals in dependence upon the detected light; and

a data processor operable to process the electrical image data signals to generate data defining coordinate measurements of the surface of the object, and to transmit the generated data on the physical data path.

99. (New) A coordinate measuring machine according to Claim 98, wherein the data processor is arranged to process the electrical image data signals to generate data defining coordinate measurements comprising three-dimensional positions.

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100. A coordinate measuring machine according to Claim 98, wherein the data processor is arranged to process the electrical image data signals to generate data defining coordinate measurements comprising points in three-dimensional space.

101. (New) A coordinate measuring machine according to Claim 98, wherein the data processor is arranged to process the electrical image data signals to generate data defining coordinate measurements comprising connected polygons in three-dimensional space.

102. (New) A coordinate measuring machine according to Claim 98, wherein the physical data path comprises a cable.

103. (New) A coordinate measuring machine according to Claim 98, further comprising a batter power supply within the apparatus to power the scanner.

104. (New) A scanner mountable on a multiply-jointed arm for movement therewith to capture data from a plurality of points on a surface of an object, the scanner having a housing enclosing:

a light source operable to emit light onto the object surface;

a light detector operable to detect light reflected from the object surface and to generate electrical image data signals in dependence upon the detected light; and

a data processor operable to process the electrical image data signals to generate data defining coordinate measurements of the surface of the object, and to transmit the generated data on a physical data path.

105. (New) A scanner according to Claim 104, wherein the data processor is arranged to process the electrical image data signals to generate data defining coordinate measurements comprising three-dimensional positions.

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106. (New) A scanner according to Claim 104, wherein the data processor is arranged to process the electrical image data signals to generate data defining coordinate measurements comprising points in three-dimensional space.

107. (New) A scanner according to Claim 104, wherein the data processor is arranged to process the electrical image data signals to generate data defining coordinate measurements comprising connected polygons in three-dimensional space.

108. A laser scanning apparatus, comprising:

a multiply-jointed arm having a plurality of arm segments and a data communication link to transmit data; and

a laser scanner mounted on an arm segment of the multiply-jointed arm for movement therewith to capture data from a plurality of points on a surface of an object, the laser scanner having a housing enclosing:

- (a) a laser to emit a laser stripe onto the object surface;
- (b) a camera operable to generate images of laser light reflected from the object surface; and
- (c) a data processor operable to process the images generated by the camera to generate processed data defining a position of the laser stripe in the images, the data processor being connected to the data communication link to transmit the processed data therealong.

109. (New) A laser scanning apparatus according to Claim 108, wherein:  
the camera is arranged to generate images comprising a plurality of pixels; and  
the data processor is arranged to process the images generated by the camera to generate processed data defining a position of the laser stripe in the images to sub-pixel accuracy.

110. (New) A laser scanning apparatus according to Claim 108, wherein the data communication link comprises a cable.

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111. (New) A laser scanning apparatus according to Claim 108, further comprising a batter power supply within the apparatus to power the laser scanner.

112. (New) A laser scanner mountable on a multiply-jointed arm for movement therewith to capture data from a plurality of points on a surface of an object, the laser scanner having a housing enclosing:

a laser to emit a laser stripe onto the object surface;  
a camera operable to generate images of laser light reflected from the object surface; and  
a data processor operable to process the images generated by the camera to generate processed data defining a position of the laser stripe in the images, the data processor being connectable to a data communication link to transmit the processed data therealong.

113. (New) A laser scanner according to Claim 112, wherein:  
the camera is arranged to generate images comprising a plurality of pixels; and  
the data processor is arranged to process the images generated by the camera to generate processed data defining a position of the laser stripe in the images to sub-pixel accuracy.

114. (New) A laser scanning apparatus, comprising:  
a multiply-jointed arm having a plurality of arm segments and a data communication link to transmit data; and  
a laser scanner mounted on an arm segment of the multiply-jointed arm for movement therewith to capture data from a plurality of points on a surface of an object, the laser scanner having a housing enclosing:

(a) a laser to emit at least one laser stripe onto the object surface;  
(b) a camera operable to generate images of laser light reflected from the object surface, each image comprising a plurality of pixels; and

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(c) a data processor operable to process the images generated by the camera to perform measurements to sub-pixel accuracy, the data processor being connected to the data communication link to transmit results of the measurements therealong.

115. (New) A laser scanning apparatus according to Claim 114, wherein the data communication link comprises a cable.

116. (New) A laser scanning apparatus according to Claim 114, further comprising a batter power supply within the apparatus to power the laser scanner.

117. (New) A laser scanner mountable on a multiply-jointed arm for movement therewith to capture data from a plurality of points on a surface of an object, the laser scanner having a housing enclosing:

a laser to emit at least one laser stripe onto the object surface;

a camera operable to generate images of laser light reflected from the object surface, each image comprising a plurality of pixels; and

a data processor operable to process the images generated by the camera to perform measurements to sub-pixel accuracy, the data processor being connectable to a data communication link to transmit results of the measurements therealong.

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